RDT

Brief

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Fiber-Reinforced PCC Unbonded Overlay

I-29 Atchison County – Performance Update

Research Development and Technology Division

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Project History

Missouri's first section of fiber-reinforced concrete (FRC) pavement was completed in July 1998. The inclusion of fibers improves energy absorbing characteristics of the concrete. Energy absorption is directly or indirectly related to properties such as crack propagation resistance, ductility, impact resistance, fatigue performance and durability. These improved properties are expected to lead to longer pavement service life.

The FRC was used in an unbonded overlay on the southbound lanes of I-29 in Atchison County between Route A and US 136. Eight test sections were established in the unbonded overlay. Three of the test sections were reinforced with steel fibers, three of the test sections were reinforced with polyolefin fibers and two of the test sections were non-reinforced PCC. There were fiber-reinforced test sections 9", 6" and 5" thick for each type of fiber reinforcement. Transverse joint spacings in the fiber-reinforced sections were 15', 30', 60' and 200'. The two non-reinforced PCC test sections were 9" and 11" and all transverse joints were spaced 15'.

Paving of the unbonded overlay was completed with few problems. Some clumping of fibers, otherwise known as "fiber balling" was observed during construction of the unbonded overlay. Fiber balls that were visible at the surface of the unbonded overlay were removed before finishing. The final surface of the overlay was established by diamond grinding the pavement at least 21 days after construction. The diamond grinding improved the initial profilograph average of 27 in./mi. to less than 11 in./mi. with a zero blanking band. This initial smoothness resulted in a contract bonus based on the final profile index. The presence of fibers in the concrete had little affect on the diamond grinding operation.

Performance

Based on pavement surveys up to one-year after construction, almost all cracking has been transverse. The transverse cracks that have developed do not appear to be reflective. The original pavement had transverse joint spacing of 61.5'. The overlay had variable joint spacing as described previously. A few of the transverse cracks in the overlay are located above joints or cracks in the existing pavement, but most are not. The one-inch interlayer treated with white curing compound seems to be adequate to isolate the overlay from the underlying pavement.

Figure 1 shows the amount of transverse cracking for all test sections. This figure represents the relative amount of cracking in each section. Detailed analysis of the cracking is present in the full report, "Evaluation of Fiber-Reinforced Unbonded PCCP Overlay". Some trends with regard to transverse cracking are apparent. Thinner sections exhibited more cracking than thicker sections; longer panels exhibited more cracking than shorter panels and the steel fiber-reinforced sections exhibited more cracking than the polyolefin fiber-reinforced sections.

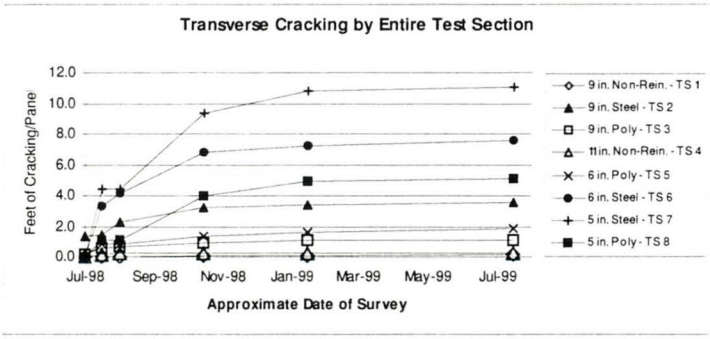

Figure 1

Most of the transverse cracks in the steel fiber-reinforced sections are within 12" of the transverse joint, apparently related to the load transfer devices. The load transfer devices are epoxy-coated dowel bars that were treated with the debonding agent, Tectyl 506. Dowel bars in the 11" non-reinforced test section are 1 ½" diameter, while the dowel bars are 1 ½" diameter in all other test sections.

The polyolefin fiber-reinforced sections with transverse joint spacing of 30' exhibited a small amount of transverse cracking based on the one-year survey. The 9" polyolefin fiber-reinforced section with 60' panels showed very little transverse cracking. The 6" polyolefin fiber-reinforced section has performed nearly as well, in terms of crack development, as the 9" polyolefin fiber-reinforced section.

Spalling at some of the transverse crack locations in the 5" steel fiber-reinforced section developed within the first year of service. Maintenance crews repaired the spalls by patching with cold mix asphalt. The patching material needed to be replaced often. Longitudinal cracks originated and extended from the dowel bars in both the 5" polyolefin and steel fiber-reinforced sections within two years of service. Due to the extensive amount of maintenance expected to be required on these two sections, the decision was made to replace these sections with a full-depth PCCP. This issue will be discussed further in a future report detailing the pavement performance after two years of service.

Future pavement surveys will be completed annually for five years at which time, a decision will be made to continue annual surveys or consider some other time period, such as every two or three years. Following the future pavement surveys, a report will be prepared which includes the latest pavement performance data.

Project Costs

The initial cost of fiber-reinforced concrete as expected is somewhat higher than conventional non-reinforced concrete. For this project, the cost of furnishing the steel fiber-reinforced concrete was $47.00/cu. yd. more than the non-reinforced concrete. Furnishing the polyolefin reinforced concrete was $60.00/cu. yd. higher than the non-reinforced concrete.

Further Information

The full report covering the construction and one-year pavement performance is now available. For additional information, please contact:

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